

The claimed invention is:

1. A process for the preparation of a nitro-substituted aromatic carboxylic acid ester comprising the steps of:

reacting a nitro-substituted aryl halide, in the absence of water and oxygen, with carbon monoxide and an alcohol in the presence of a metal catalyst and a proton acceptor to form the corresponding nitro-substituted aromatic carboxylic acid ester.

2. A process of claim 1, wherein the aryl group of said nitro-substituted aryl halide is a substituted or unsubstituted, monocyclic or polycyclic aryl group or heteroaryl group containing at least one heteroatom of N, O, or S;

said carbon monoxide is present at a pressure of 14.7- 1100 psi;

said alcohol is a linear or branched, substituted or unsubstituted C<sub>1</sub>-C<sub>5</sub> alkyl alcohol;

said metal catalyst is a heterogeneous or homogeneous transition metal catalyst wherein the transition metal is selected from the group consisting of palladium, platinum, nickel, cobalt, rhodium, and ruthenium; and

said proton acceptor is a tertiary amine base.

3. A process of claim 2, wherein said tertiary amine base is selected from the group consisting of triethylamine and tri-n-butylamine.

4. A process of claim 2, wherein said metal catalyst is a homogeneous catalyst of dichlorobis(triphenylphosphine)palladium or dibromobis(triphenylphosphine)palladium present in an amount of between about 0.0005 to 0.5 molar equivalents based on said nitro-substituted aryl halide.

5. A process of claim 2, wherein said homogeneous catalyst is prepared *in situ* by reacting a phosphine with a palladium compound in a ratio of about 1-6 atom equivalents of phosphorus per

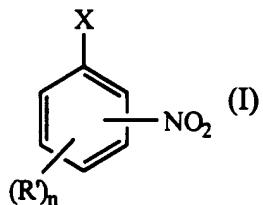
atom equivalent of palladium, wherein said phosphine is selected from the group consisting of trimethylphosphine, triethylphosphine, tri-n-propylphosphine, tri-i-propylphosphine, tri-n-butylphosphine, tri-t-butylphosphine, tricyclohexylphosphine, triphenylphosphine, tri-o-tolylphosphine, methyldiphenylphosphine, 1,2-bis(diphenylphosphinoethane), and 1,3-bis(diphenylphosphino)propane and

said palladium compound is selected from the group consisting of palladium(II) acetate, palladium(II) chloride, dichlorobis(acetonitrile)palladium(II), dichlorobis(benzonitrile)palladium(II), bis(dibenzylidineacetone)palladium(0), tris(dibenzylidineacetone)dipalladium(0), and tris(dibenzylidineacetone)dipalladium(0) chloroform adduct.

6. A process of claim 2, wherein said metal catalyst is a heterogeneous catalyst of palladium metal deposited on activated carbon present in an amount of between about 1 weight percent and 500 weight percent based on said nitro-substituted aryl halide.

7. A process of claim 1, wherein said reacting step occurs in the presence of a solvent selected from the group consisting of an excess of said alcohol, an excess of said proton acceptor, an aliphatic hydrocarbon, an aromatic hydrocarbon, a cyclic ether, an acyclic ether, a polar aprotic solvent, and mixtures thereof.

8. A process of claim 1, wherein said nitro-substituted aryl halide is of formula (I):

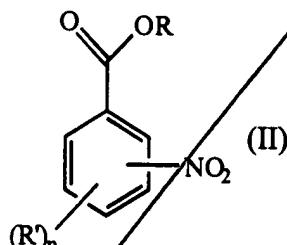


wherein

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X is chloro, bromo, or iodo;  
n is an integer of 1-4; and  
R' is, independently, a C<sub>1</sub>-C<sub>10</sub> alkyl group, a C<sub>2</sub>-C<sub>10</sub> alkenyl group, a C<sub>2</sub>-C<sub>10</sub> alkynyl group, a C<sub>4</sub>-C<sub>10</sub> aryl or heteroaryl group, an ether, a thioether, a nitro, a trifluoromethyl, a fluoro, cyano, or acyl group; or together with the phenyl ring forms a substituted or unsubstituted fused polycyclic ring system; and

said corresponding nitro-substituted aromatic carboxylic acid ester is of formula (II):



wherein

n and R' are as defined above; and

R is a C<sub>1</sub>-C<sub>5</sub> alkyl group.

9. A process of claim 8, wherein n is 1, R' is a trifluoromethyl group, and R is a methyl or n-butyl group.

10. A process of claim 9, wherein R' is para to halide X of formula (I) and the nitro group is ortho to halide X of formula (I).

11. A process for the preparation of a thioether-substituted aromatic carboxylic acid ester comprising the steps of:

preparing a nitro-substituted aromatic carboxylic acid ester according to claim 1, and

reacting the said nitro-substituted aromatic carboxylic acid ester with a thiolate anion to form the corresponding thioether-substituted aromatic carboxylic acid ester.

12. A process for the preparation of a thioether-substituted aromatic carboxylic acid ester comprising the step of:

reacting a nitro-substituted aromatic carboxylic acid ester with a thiolate anion to form the corresponding thioether-substituted aromatic carboxylic acid ester.

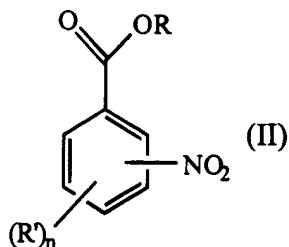
13. A process of claim 12, wherein said thiolate anion is prepared *in situ* from a thiol and a base, wherein said base is selected from the group consisting of tertiary amines, alkali or alkaline earth metal hydroxides, and alkali or alkaline earth metal carbonates.

14. A process of claim 13, wherein said thiolate anion is a compound of the formula  $R''S^{\cdot}M^+$ , wherein  $R''$  is a  $C_1$ - $C_{10}$  alkyl group or a  $C_4$ - $C_{10}$  aryl or heteroaryl group and M is selected from the group consisting of sodium, potassium and ammonium.

15. A process of claim 12, wherein said reacting step is conducted in a homogeneous solvent system comprising a water-miscible solvent and water, or in a phase-transfer solvent system comprising a water-immiscible organic solvent, a phase-transfer catalyst, and, optionally, water.

16. A process of claim 15, wherein said reacting step is conducted in a phase-transfer solvent system wherein said phase-transfer catalyst is a tetralkylammonium or tetralkylphosphonium salt selected from the group consisting of tetrabutylammonium bromide, tetrabutylammonium chloride, methyltributylammonium chloride, methyl trioctylammonium chloride, and tetrabutylphosphonium bromide; and said water-immiscible solvent is selected from the group consisting of an aliphatic hydrocarbon, an aromatic hydrocarbon, a cyclic ether, and an acyclic ether.

17. A process of claim 14, wherein said nitro-substituted aromatic carboxylic acid ester is of formula (II):



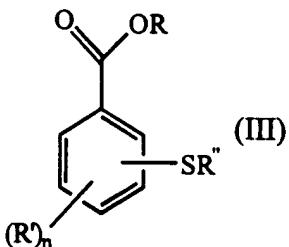
wherein

n is an integer of 1-4;

R' is, independently, a C<sub>1</sub>-C<sub>10</sub> alkyl group, a C<sub>2</sub>-C<sub>10</sub> alkenyl group, a C<sub>2</sub>-C<sub>10</sub> alkynyl group, a C<sub>4</sub>-C<sub>10</sub> aryl or heteroaryl group, an ether, a thioether, a nitro, a trifluoromethyl, a fluoro, cyano, or acyl group; or together with the phenyl ring forms a substituted or unsubstituted fused polycyclic ring system; and

R is a C<sub>1</sub>-C<sub>5</sub> alkyl group; and

said corresponding thioether-substituted aromatic carboxylic acid ester is of formula (III):



wherein

n, R', and R are as defined above.

18. A process of claim 17, wherein R' is para to the ester group of formula (II) and the nitro group is ortho to the ester group of formula (II).

19. A one-pot process for the preparation of a thioether-substituted aromatic carboxylic acid ester comprising the steps of:

reacting a nitro-substituted aryl halide, in the absence of water and oxygen, with carbon monoxide and an alcohol in the presence of a metal catalyst and a proton acceptor to form the corresponding nitro-substituted aromatic carboxylic acid ester; and

reacting without isolating said corresponding nitro-substituted aromatic carboxylic acid ester with a thiolate anion to form the corresponding thioether-substituted aromatic carboxylic acid ester.

20. A compound of methyl 2-nitro-4-trifluoromethylbenzoate.

21. A compound of butyl 2-nitro-4-trifluoromethylbenzoate.